MATTER IN ITS ELECTRICALLY EXPLOSIVE STATE.

By FRANCIS E. NIPHER.

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In 1815 Singer published in the *Philosophical Magazine*[1] an account of experiments made in Holland by De Nelis, and repeated by him, which illustrated what he called the explosive effects of electricity. At that time the one-fluid theory was generally held by those familiar with electrical phenomena. It was, however, their belief that the electrical discharge came from the positive terminal.

Singer made use of a battery of jars having an external tin-foil area of 75 square feet. The positive terminal of this battery was separated from a terminal leading to a wire of lead having a diameter of 0.01 inch. This lead wire was within a small metal cylinder formed by boring a hole into a metal rod. One end of the wire was in contact with the bottom of the bore, the other being attached to a copper wire through which the discharge was sent to the lead wire. This leading in wire was surrounded by wax, and the lead wire was surrounded by oil. The lead wire was exploded by each discharge. The metal cylinder was stronger than any gun-barrel. It, however, was shattered by the explosive effects, the leading in wire was blown out and the liquid was sometimes thrown to the height of fifty feet when the metal cylinder did not burst.

At the present time it seems evident that, in these experiments, the lead wire was being suddenly drained of its negative corpuscles. What may properly be called a rarefaction wave was sent along the wire. When in this condition each atom of lead repels every other atom. The lead becomes explosive. There are heat effects involved also, which assist in the separation of the atoms, but which alone do not seem to be capable of accounting for the results.

It seemed to the present writer that it might be of interest to

[1] *Phil. Mag.*, Vol. 46, p. 161.

determine whether the explosive effects would be the same when the negative discharge was sent through the wire as when the positive terminal was used. In the former case a compression wave is sent through the corpuscular nebula within the wire. The repulsion effects are impressed upon the oil surrounding the wire. In the latter case the nature of the action seems to be essentially different, as has been pointed out above.

The wire was placed within a glass tube as shown in the adjoining figure. The internal diameter of various samples varied between one and two millimeters. The length of the tube was 10 cm. The ends of the tube were provided with copper leading-in wires fitting more or less closely the bore of the tube and to which the fine wire was attached, as shown in the adjoining figure. The walls of the tube were from one to two millimeters in thickness. The space within the tube around the wire was completely filled with coal-oil, all air being excluded. The ends of the tube and the leading-in

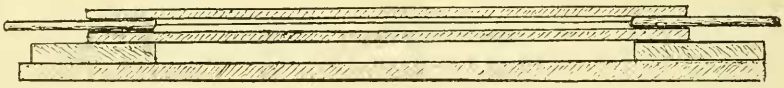

Fig. 1.

wires were sealed with sealing wax, which held the leading wires in place and secured these wires and the glass tube to supporting blocks of hard rubber.

The source of electricity was an influence machine, provided with a condenser consisting of twenty sheets of glass 66 cm. square, each plate having a tin-foil coating 30 cm. square. These plate condensers were connected in multiple, the tin-foil area being about 20 square feet on each side. A pivotally mounted ground contact could be connected to either terminal of the machine. By means of a similar contact rod either terminal could be connected with one of a set of discharge rods, provided with an adjustable spark gap between the knobs. The other discharge rod was connected with the water-pipe system of the building by means of two No. 8 copper wires in multiple. The apparatus shown in the figure was in this ground line. The ground for the machine was in the yard outside

of the building. The results were the same when the two grounds were thus independent as when they were united.

The wire to be exploded, contained within the glass tube of the figure, was a quarter ampere fuse wire, having a diameter of 0.115 mm. A small copper wire having a diameter of 0.105 mm. was also used with similar results.

A single discharge from either the positive or the negative side of the condenser caused the tube of glass to be shattered into fragments so minute that their impact upon the face of the observer when standing six or eight feet distant, produced no harmful effect. On several occasions, when the discharge came before it was expected, their impact upon the eyes was also harmless.

The small glass tube shown in the figure was enclosed in a larger tube having an internal diameter of about half an inch. This tube was also enclosed in a strip of cardboard. In this way the dust into which the inner tube was converted could be collected. It could only be recognized as glass on examination with a pocket lens.

The effect of the explosion upon the outer tube, the ends of which were open, was found to be in all cases more marked when the compression or negative discharge was sent through the wire than when the discharge rods and wire were connected with the positive terminal. In some cases the rarefaction wave would produce no apparent effect upon the outer tube, while the negative or compression wave would crack it or shatter it into three or four fragments.

In order to make comparative tests, the apparatus shown in the figure was constructed in pairs, the two tubes being cut from adjoining parts of the same glass tube. This was also done with the larger tubes which were placed between the supporting blocks and surrounded the small tube shown in the figure. In some cases two fuse wires or one fuse wire and one copper wire were placed in parallel within the tube. In this way the explosive effects were somewhat varied. In all cases the greater effects of the compression discharge were so marked that there appears to be no doubt of the result.

In order to compare the heat effects of an ordinary direct current, the wire was, by a switch connection, subjected to the current

from a separately excited 250-volt dynamo. The expansion effects then resulted in forcing the oil out through the sealing wax at the ends of the glass tube. No explosive effects were produced. The same experiment was repeated by switching the lead wire into a ground line attached to a city power plant, the impressed potential being 600 volts. The results were exactly the same as in the previous case, so far as explosive effects were concerned. The wire was fused and partly converted into a fine powder.